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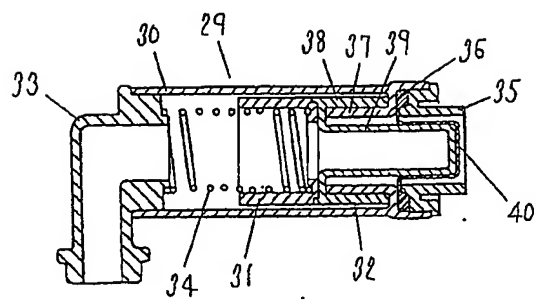
(54) **Dust collection indicator for vacuum cleaners.**

(57) A dust collection indicator (29) for a vacuum cleaner includes a valve (36) for separating the atmospheric pressure and a vacuum pressure which is developed while a motor fan (24) of the vacuum cleaner is driven. The valve is (29) deformable by a differential pressure created between the vacuum pressure and the atmospheric pressure so as to displace first and second pointers (31, 32) in a direction away from the atmospheric pressure side without causing leakage of air during displacement

of the pointers (31, 32), thus preventing undue reduction of the suction force. The pressure at which the valve (36) starts deforming can be set to a level closer to the atmospheric pressure than the level as obtained by the conventional indicator, so that the pointers (31, 32) are displaced substantially in proportion to the quantity of dust being collected in a dust bag (22). This arrangement enables the user to recognize the current quantity of dust accumulated in the vacuum cleaner at all times.

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FIG. 3



DUST COLLECTION INDICATOR FOR VACUUM CLEANERS

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates generally to vacuum cleaners, and more particularly to a dust collection indicator incorporated in a vacuum cleaner for indicating the quantity of dust collected in the vacuum cleaner.

2. Description of the Prior Art:

One example of known mechanical dust collection indicators is shown here in Figs. 1 and 2 of the accompanying drawings. The dust collection indicator 1 includes a first pointer 2 colored in green, for example, and a second pointer 3 colored in red, for example, and firmly fitted with the first pointer 2, a compression coil spring 4 urging the first and second pointers 2, 3 backward, a ring-shaped end cap 6 disposed behind the second pointer 3 and having a central hole 5, a transparent hollow cylindrical pointer tube 7 receiving therein the spring 4, the first and second pointers 2, 3 with its rear end partly closed by the end cap 6, and a connecting pipe 9 interconnecting the front end of the pointer tube 7 and a duct collecting chamber 8 in the body 10 of a vacuum cleaner. The cleaner body 10 includes a front body portion 11 covering an upper part of the duct collecting chamber 8. The front body portion 11 has a recessed upper portion 12 in which the dust collection indicator 1 is disposed with the connecting pipe 9 communicating with the dust collecting chamber 8. A cover plate 13 attached to the front body portion 11 to close the recessed upper portion 12 has a window 14 through which either of the two pointers 2, 3 can be observed from the outside of the cleaner depending on the quantity of dust collected in a dust bag 15 disposed in the dust collecting chamber 8. In the initial condition, the green-colored first pointer 2 is observed.

While the vacuum cleaner is operating, dust-laden air passes through the dust bag 15 from the inside to the outside, the dust being collected in the dust bag. As the dust bag 15 fills up with dust, the pressure in the dust collecting chamber 8 gradually goes down below the atmospheric pressure. This pressure drop sets up a differential pressure between a vacuum pressure acting on the first pointer 2 through the connecting pipe 9 and the atmospheric pressure acting on the second pointer 3 through the end cap 6. The differential pressure thus created acts on the second pointer 3 through the central hole 5 in the end cap 6, tending to

move the first and second pointers 2, 3 forwardly toward the connecting pipe 9 against the force of the spring 4. As the quantity of dust collected in the dust bag 15 further increases, the pressure in the dust collecting chamber 8 falls below a predetermined level whereupon the differential pressure acting on the second pointer 3 exceeds the force of the spring 4. Consequently, the first and second pointers 2, 3 are displaced toward the connecting pipe 9. Now, the red-colored second pointer 3 is observed through the window 14. With this change of color of the pointers 2, 3, the user can readily understand that the dust bag must be emptied.

With this construction, if the first and second pointers 2, 3 of the conventional indicator 1 are displaced toward the connecting pipe 9, the outside air flows through the window 14, through the central hole 5, through the pointer tube 7 and through the connecting pipe 9 into the dust collecting chamber 8, thereby lowering the suction power of the vacuum cleaner. Thus, the pre-load on the first and second pointers 2, 3, i.e. the force of the spring 4 is set such that the forward displacement of the first and second pointers takes place when the dust bag substantially fills up with dust. The conventional indicator 1, therefore, has a drawback that the amount of displacement of the first and second pointers 2, 3 is not proportional to the quantity of dust collected in the dust bag.

In the case of dust consisting essentially of fibrous material, the pressure in the dust collecting chamber 8 is still above the predetermined level even when the dust bag is fully occupied and, therefore, displacement of the first and second pointers 2, 3 does not take place. A continuous use of the vacuum cleaner causes the bursting or rupture of the dust bag which will result in a malfunction of a motor fan 16 due to the dust caught up into the motor fan 16. Even if the first and second pointers 2, 3 are finally displaced, the dust has accumulated inside a hose connected to the body 10 of the vacuum cleaner, making it difficult to exchange the dust bag 15. Alternatively, the dust has spilled out from the dust bag 15 into the dust collecting chamber 8, requiring cleaning of the dust collecting chamber 8.

SUMMARY OF THE INVENTION

With the foregoing drawbacks of the prior art in view, it is a general object of the present invention to provide a dust collection indicator for a vacuum cleaner, which is easy to handle and reliable in operation.

A more specific object of the present invention is to provide a dust collection indicator which is capable of indicating the dust collecting capacity substantially in proportion to the quantity of dust being collected in the dust bag in a vacuum cleaner.

In brief, a dust collection indicator of this invention includes a valve for separating the atmospheric pressure and a vacuum pressure which is developed while a motor fan of the vacuum cleaner is driven. The valve is deformable by a differential pressure created between the vacuum pressure and the atmospheric pressure so as to displace at least one pointer in a direction away from the atmospheric pressure side without causing leakage of air during displacement of the pointer, thus preventing undue reduction of the suction force. The pressure at which the valve starts deforming can be set to a level closer to the atmospheric pressure than the level obtained by the conventional indicator, so that the pointer is displaced substantially in proportion to the quantity of dust being collected in a dust bag. This arrangement enables the user to recognize the current quantity of dust accumulated in the vacuum cleaner at all times.

The valve is disposed on the atmospheric pressure side relative to the pointer and gripped between a pointer tube and a tubular end cap. This construction is advantageous in that the vacuum pressure and the atmospheric pressure are isolated reliably, the valve is protected against damage, and the indicator can be assembled with utmost ease.

More specifically, according to the present invention, there is provided a dust collection indicator for a vacuum cleaner including a motor fan drivable to develop a vacuum pressure, which comprises a substantially transparent pointer tube receptive of the vacuum pressure; a valve disposed in the pointer tube for separating the vacuum pressure and the atmospheric pressure, the valve being deformable by a differential pressure created between the vacuum pressure and the atmospheric pressure; at least one pointer slidably disposed in the pointer tube and displaceable by the deformation of the valve; and a spring disposed in the pointer tube for urging the pointer toward a atmospheric pressure side to prevent the pointer from displacing until the vacuum pressure reaches to a predetermined level.

The above and other objects, features and advantages of the present invention will become more apparent from the following description when making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view, with parts broken away and in cross section, of a vacuum cleaner having a conventional dust collection indicator;

Fig. 2 is an enlarged cross-sectional view of the conventional dust collection indicator;

Fig. 3 is a cross-sectional view of a dust collection indicator according to a first embodiment of this invention;

Fig. 4 is a side view, with parts broken away and in cross section, of a vacuum cleaner incorporating the dust collection indicator shown in Fig. 3;

Fig. 5 is a view similar to Fig. 3, but showing the dust collection indicator in an operating condition;

Fig. 6 is a cross-sectional view of a dust collection indicator according to a second embodiment of this invention;

Fig. 7 is a fragmentary cross-sectional view of a dust collection indicator according to a third embodiment of this invention; and

Fig. 8 is a view similar to Fig. 7, but showing the dust collection indicator in an operating condition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference characters designate corresponding parts throughout several views, Fig. 4 shows a vacuum cleaner incorporating a dust collection indicator according to this invention.

As shown in Fig. 4, the vacuum cleaner includes a body 21 having a dust bag 22 received in a dust collecting chamber 23 for precipitating and collecting dust and dirt which are sucked from the carpet or floor through a cleaning attachment assembly composed of a suction nozzle, extension wands and a hose (neither shown). A motor fan 24 and a cord winding device (not shown) are disposed in the cleaner body 21 behind the dust collecting chamber 23. The cleaner body 21 includes an upper cover or lid 25 extending above the dust collecting chamber 23 for opening and closing the same. The upper lid 25 has a rear end fitted in an upper portion 26 of the cleaner body 21, the front end of the upper lid 25 being locked on the cleaner body 21 by the action of a latch 27. The upper lid 25 has an outwardly facing central recess 28 in which the dust collection indicator 29 is disposed.

As shown in Fig. 3, the dust collection indicator 29 includes a transparent hollow cylindrical pointer tube 30, a first pointer 31 colored in green and a second pointer 32 colored in red which are slidably disposed in the pointer tube 30 and displaceable in unison with each other, a connecting pipe 33 interconnecting the dust collecting chamber 23 and the

inside of the pointer tube 30, a compression coil spring 34 disposed between the connecting pipe 33 and the first pointer 31 for urging the first and second pointers 31, 32 away from the connecting pipe 33, a tubular end cap 35 fitted in an end of the pointer tube 30 remote from the connecting pipe 33, and a substantially hat-shaped pointer valve 36 gripped at its outer periphery by and between the pointer tube 30 and the end cap 35 for fluid-tightly separating the second pointer side and the end cap side, the pointer valve 36 being formed of a flexible material such as rubber.

The pointer tube 30 has a double-tube structure including an inner tube 37 integral with the rear end of the pointer tube 30 adjacent to the end cap 35 and extending therefrom toward the connecting pipe 33 for engagement with the second pointer 32 to set the initial position of the second pointer 32. The first pointer 31 and the second pointer 32 are fitted together through the form-locking engagement. The second pointer 32 has a double-tube structure including an outer tube 38 and an inner hub or projection 39 integral with an end of the outer tube 38 adjacent to the first pointer 31 and extending therefrom toward the end cap 35. The tubular projection 39 projects into the tubular end cap 35 and is snugly fitted in a thin central projection or crown 40 of the hat-shaped pointer valve 36. The tubular end cap 35 retaining the periphery of the pointer valve 36 is centrally opened so that the cleaner body 21 (Fig. 4) communicates with the atmosphere through the tubular end cap 35. The connecting pipe 33 has a front end fitted in an opening 41 formed in the bottom of the recess 28 so that the connecting pipe 33 communicates with the dust collecting chamber 23. With this construction, one side of the pointer valve which is located adjacent to the end cap 35 is exposed to the atmospheric pressure, while the opposite side which is located adjacent to the second pointer 32 is subjected to a vacuum pressure developed during the operation of the motor fan 24. The pointer valve 36 serves to displace the first and second pointers 31, 32 toward the connecting pipe 33 depending on a differential force created between the force of the spring 34 and a suction force which acts inside the inner tube 37 in a direction toward the dust collecting chamber 23 based on a differential pressure between the atmospheric pressure and the vacuum pressure.

A cover plate 42 (Fig. 4) is fitted in the recess 28 and has a window 43 disposed above the pointer tube 30. When the motor fan 24 is in the inoperative condition, the green-colored first pointer 31 is observed through the window 43.

The dust collection indicator 29 of the foregoing construction operates as follows. While the vacuum cleaner is operating, dust and grit particles

are collected in the dust bag 22. As the dust accumulates in the dust bag 22, the flow rate of air drawn by the motor fan 24 reduces and hence the vacuum pressure or suction developed by the motor fan 24 within the dust collecting chamber gradually goes down to a level below the atmospheric pressure. As the quantity of dust collected in the dust bag further increases, the vacuum pressure in the dust collecting chamber 23 falls below a predetermined level whereupon, owing to a differential pressure acting inside the inner tube 37, a suction force tending to pull the central projection 40 of the pointer valve 36 toward the connecting pipe 33 exceeds the force of the spring 34. In this instance, an outer peripheral edge portion of the central projection 40 is inwardly flexed or otherwise bent into a U shape so that the distal end of the central projection 40 is slightly displaced toward the connecting pipe 33, thereby moving the first and second pointers 31, 32 toward the connecting pipe 33 correspondingly.

As the quantity of dust collected in the dust bag increases, the vacuum pressure in the dust collecting chamber 23 increases and, therefore, the suction force acting on the central projection 40 of the pointer valve 36 progressively increases. Consequently, the U-shaped flexed portion of the pointer valve 36 is gradually displaced toward the connecting pipe 33, thereby causing the first and second pointers 31, 32 to move progressively toward the connecting pipe 33. In this instance, both of the green-colored first pointer 31 and the red-colored second pointer 32 are observed through the window 43.

When the dust collected in the dust bag 22 exceeds a predetermined quantity, the first and second pointers 31, 32 are fully displaced toward the connecting pipe 33, as shown in Fig. 5. In this instance, only the red-colored second pointer 32 is observed through the window 43. From the red-colored second pointer 32, the user can readily understand that the dust bag 22 must be replaced with a new dust bag before starting operation of the vacuum cleaner again under a strong suction force.

Since the pointer valve 36 is gripped between the pointer tube 30 and the end cap 35 to completely isolate a vacuum pressure portion disposed on the second pointer side and an atmospheric pressure portion disposed on the end cap side, the outside air is completely prevented from flowing into the dust collecting chamber 23 even when the central projection 40 of the pointer valve 36 and the first and second pointers 31, 32 are displaced. Thus, a wasteful reduction of the suction force can be avoided.

Since the suction force is developed without losses, the pre-loading force of the spring 34 acting on the first and second pointers 31, 32 can be

reduced so that the central projection 40 of the pointer valve 36 starts flexing into a U shape even when the vacuum pressure in the dust collecting chamber 23 is still low, i.e. when the quantity of dust collected in the dust bag 22 is still small. As a result, the first and second pointers 31, 32 are displaced progressively within the range of the window 43 substantially in direct proportion to a reduction of the pressure in the dust collecting chamber 23 which corresponds to an increase in the quantity of dust collected in the dust bag 22. This enables the user to recognize the current dust level or quantity with accuracy. Such proportional displacement of the first and second pointers 31, 32 also takes place even when the dust being collected in the dust bag 22 consists mainly of fibrous material. When the dust bag 22 fills up with the fibrous dust, the second pointer 32 is displaced to a position directly below the window 43. Thus, various difficulties resulting from the continuous use of the fully occupied dust bag 22 can, therefore, be obviated.

Furthermore, with the provision of the pointer valve 36, there is no stream of air created in within pointer tube 30. Consequently, the pointer tube 30 is free from adhesion of the dust which would otherwise hinder smooth movement of the first and second pointers 31, 32, stain the pointer tube 30 to thereby make it difficult to identify the pointers 31, 32, and damage the pointer valve 36. Since the displacement of the first and second pointers 31, 32 is determined by a static differential pressure acting on the central projection 40 of the pointer valve 36, the pre-loading force of the spring 34 and, more particularly, the force of the spring 34 at the maximum displacement of the pointers 31, 32 can easily be set.

The pointer valve 36 disposed to the atmospheric pressure side relative to the second pointer 32 ensures that the central projection 40 including the U-shaped flexed portion closely fitted with the inner projection 39 of the second pointer 32 and the inner tube 37 of the pointer tube 30 while the motor fan 24 is operating. With this arrangement, most of the suction force resulting from the differential pressure and acting on the pointer valve 36 to pull or draw the central portion 40 toward the connecting pipe 33 is retained jointly by an outer peripheral surface of the inner projection 39 and an inner peripheral surface of the inner tube 37. In other words, the bent or flexed portion of the central projection 40 is subjected to only a small suction force. Furthermore, the central projection 40 deforms smoothly without involving relative sliding motion between itself and either of the inner projection 39 and the inner tube 37. The pointer valve 40 is, therefore, durable in construction and reliable in operation.

The first pointer 31 and the second pointer 32 are urged against each other by the spring 34 and the pointer valve 36 and hence they are slidably movable within the pointer tube 30 as a single unit even when the first and second pointers 31, 32 are firmly fitted together through a form-locking engagement. For assembling the dust collection indicator 29, the first and second pointers 31, 32 need to be merely placed in the pointer tube 30 without joining them together. This facilitates the assembling operation of the dust collection indicator 29.

The atmospheric pressure side and the vacuum pressure side are separated easily by simply gripping the pointer valve 36 between the pointer tube 30 and the end cap 35. Furthermore, since the movement of the second pointer 32 in a direction toward the atmospheric pressure side is limited by the inner tube 37, the central projection 40 of the pointer valve 36 is protected from being tensioned by the inner projection 39 of the second pointer 32 while the motor fan 24 is stopped, i.e. when the vacuum cleaner is not used. Thus, the durability of the central projection 40 of the pointer valve 36 is not deteriorated.

Fig. 6 shows a second embodiment of this invention which aims mainly at the provision of a low-cost dust collection indicator.

The dust collection indicator 29a differs from the indicator 29 of the first embodiment shown in Figs. 3 - 5 in that a pointer valve 36 including a thin central projection 40 is integral with a tubular end cap 35 of an elastic material such as rubber.

With this integral formation of the pointer valve 36 and the end cap 35, the number of components of the indicator 29a is smaller by one than that of the indicator 29 of the first embodiment and hence the indicator 29a can be assembled easier at a lower cost than the indicator 29.

The elastic end cap 35 firmly fitted in the pointer tube 30 provides a hermetic seal between them. Thus, the air-tight structure can be provided easily as compared to the indicator 29 in which a separate pointer valve 36 is used.

Figs. 7 and 8 show a modified form of the dust collection indicator according to this invention. The modified indicator 29b includes a single pointer 50 having a green-colored, hollow-cylindrical pointer body 50a and a cup-shaped projection 51 extending coaxially from a rear end of the pointer body 50a and fitted with the central projection 40 of a pointer valve 36. The projection 51 is colored in red and hence serves as a second pointer. A compression coil spring 34 disposed between a connecting pipe 33 and the pointer 50 urges the pointer 50 toward the pointer valve 36 until the pointer 50 abuts against a stepped portion 52 of a pointer tube 30. In the initial state, the green-

colored pointer body 50a is disposed directly below the window 43.

When the suction force acts on the pointer valve 36 of the dust collection indicator 29a, an outer peripheral portion of the central projection 40 is inwardly flexed or bent into a U shape, thereby displacing the cup-shaped projection 51 toward the connecting pipe 33. In this instance both of the green-colored pointer body 50a and the red-colored projection 51 are observed through the window 43. When the dust being collected in the dust bag exceeds a predetermined quantity, the pointer 50 is fully displaced toward the connecting pipe 33, as shown in Fig. 8. At that time, only the red-colored projection 51 is observed through the window 43. This means that the dust bag fills up with dust and hence must be emptied or replaced with a new one. The indicator 29b of this embodiment has only one pointer 50 and hence can be manufactured at a low cost.

As described above, the dust collection indicators of this invention are reliable in operation and capable of indicating the dust collecting capacity substantially in proportion to the quantity of dust being collected in the dust bag.

Obviously various minor changes and modifications of the present invention are possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

A dust collection indicator (29) for a vacuum cleaner includes a valve (36) for separating the atmospheric pressure and a vacuum pressure which is developed while a motor fan (24) of the vacuum cleaner is driven. The valve is (29) deformable by a differential pressure created between the vacuum pressure and the atmospheric pressure so as to displace first and second pointers (31, 32) in a direction away from the atmospheric pressure side without causing leakage of air during displacement of the pointers (31, 32), thus preventing undue reduction of the suction force. The pressure at which the valve (36) starts deforming can be set to a level closer to the atmospheric pressure than the level as obtained by the conventional indicator, so that the pointers (31, 32) are displaced substantially in proportion to the quantity of dust being collected in a dust bag (22). This arrangement enables the user to recognize the current quantity of dust accumulated in the vacuum cleaner at all times.

Claims

1. A dust collection indicator (29; 29a; 29b) for a vacuum cleaner including a motor fan (24) drivable to develop a vacuum pressure, which

includes a substantially transparent pointer tube (30; 52) receptive of the vacuum pressure, at least one pointer (31, 32; 50) slidably disposed in said pointer tube (30; 52), and a spring (34) disposed in said pointer tube (30; 52) for urging said pointer (31, 32; 50) toward an atmospheric pressure side to prevent said pointer (31, 32; 50) from displacing until the vacuum pressure reaches to a predetermined level, characterized in that a valve (36) is disposed in said pointer tube (30; 52) for separating the vacuum pressure and the atmospheric pressure, said valve (36) being deformable by a differential pressure created between the vacuum pressure and the atmospheric pressure, said pointer (31, 32; 50) being displaceable by the deformation of said valve (36).

2. A dust collection indicator according to claim 1, wherein said valve (36) is substantially hat shape and includes a thin central projection (40) disposed on the atmospheric pressure side relative to said pointer (31, 32; 50).

3. A dust collection indicator according to claim 2, wherein said pointer (31, 32; 50) includes a projection (39; 51) fitted with said central projection (40) of said hat-shaped valve (36).

4. A dust collection indicator according to claim 3, wherein said pointer (31; 32) includes a colored first pointer (31) on which said spring (34) acts, and a second pointer (32) including said projection (39) and having a color different from the color of said first pointer (31), said pointer (32) being disposed between said first pointer (31) and said valve (36).

5. A dust collection indicator according to claim 3, wherein said pointer (50) includes a colored body (50a) on which said spring (34) acts, said projection (51) being integral with said pointer body (50a) and having a color different from the color of said pointer body (50a).

6. A dust collection indicator according to claim 2, further including a substantially annular end cap (35) firmly fitted in an end of said pointer tube to hold said valve (36) between said pointer tube (30) and said end cap (35).

7. A dust collection indicator according to claim 6, wherein said end cap (35) and said valve (36) are integral with each other and formed of an elastic material.

8. A dust collection indicator according to claim 3, wherein said pointer tube (30) having a

portion (37; 52) engageable with said pointer (31, 32; 50) to limit the movement of said pointer (31, 32; 50) toward the atmospheric pressure side.

9. A dust collection indicator according to claim 8, wherein said pointer tube (30) has a double-tube structure including an inner tube (37) extending in a direction opposite to the atmospheric pressure side, said inner tube (37) constituting said portion of said pointer tube (30).

10. A dust collection indicator according to claim 8, wherein said portion (52) of said pointer tube (30) comprises a stepped portion (52) projecting inwardly of said pointer tube (30).

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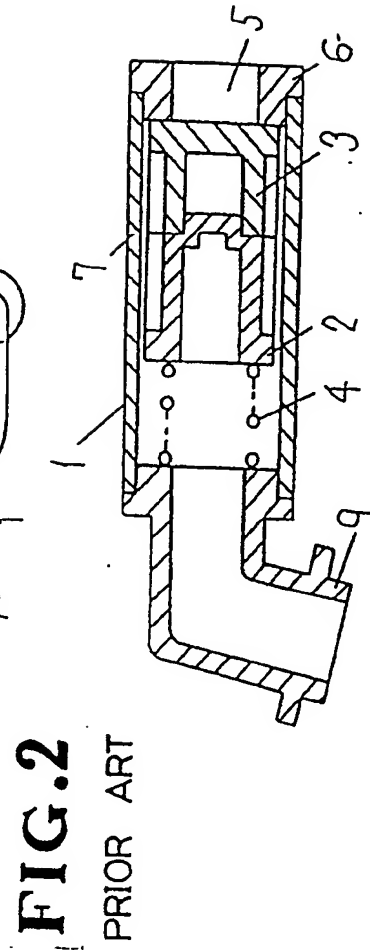
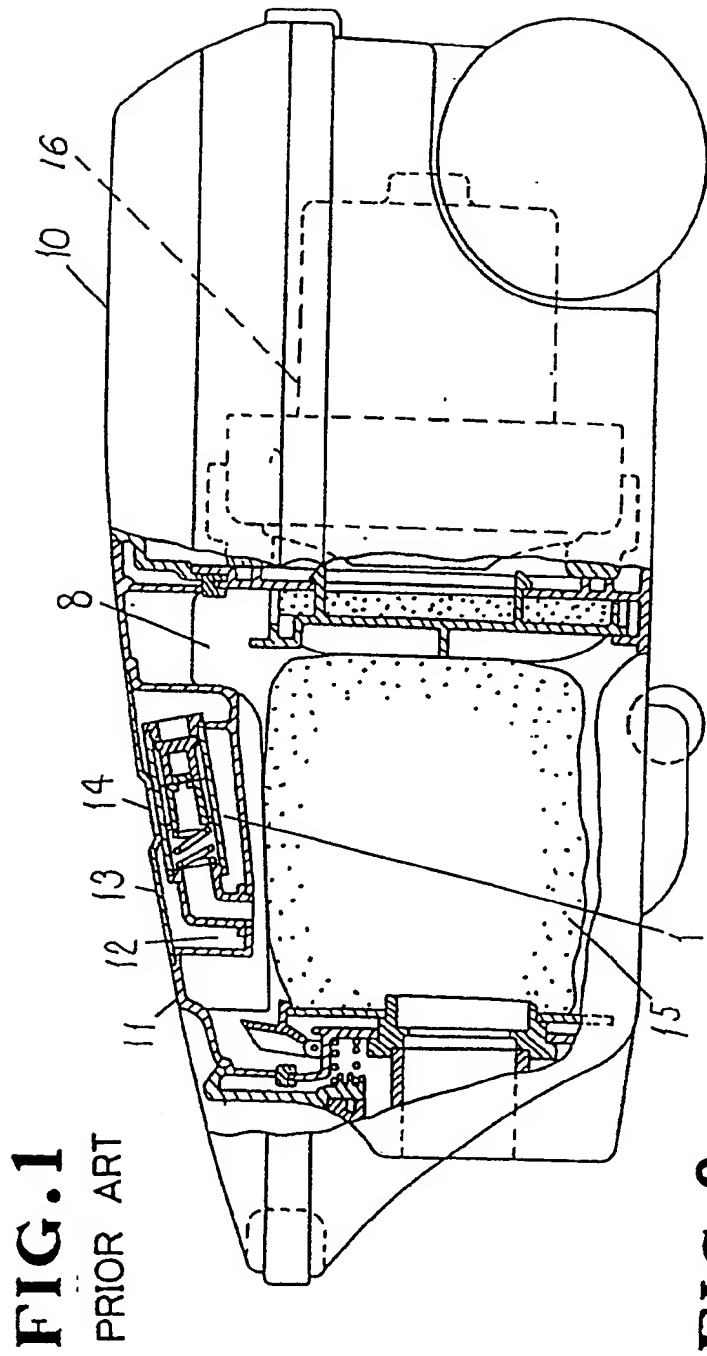


FIG. 3

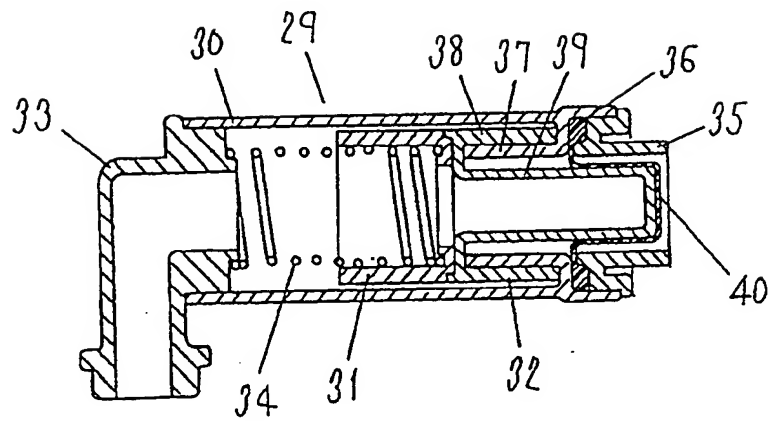


FIG. 4

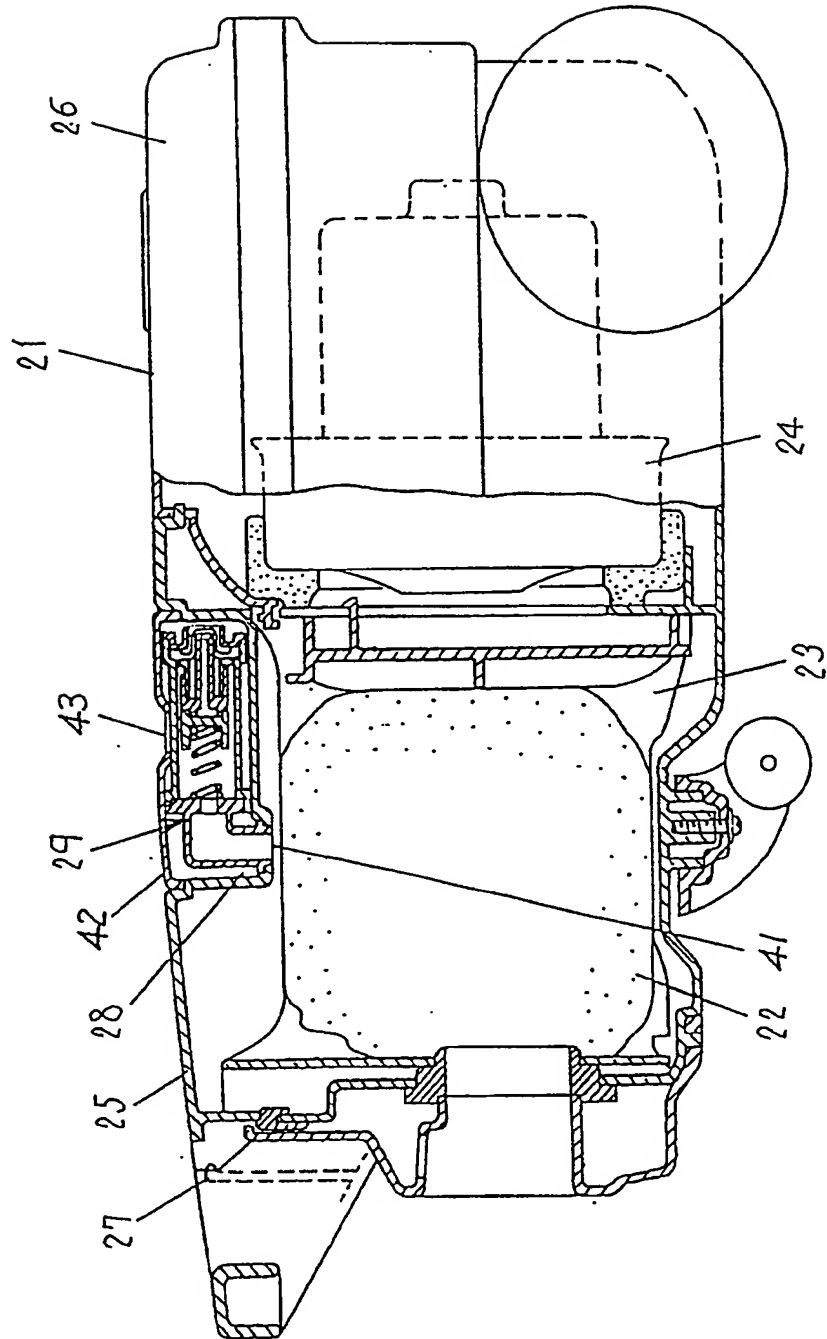


FIG. 5

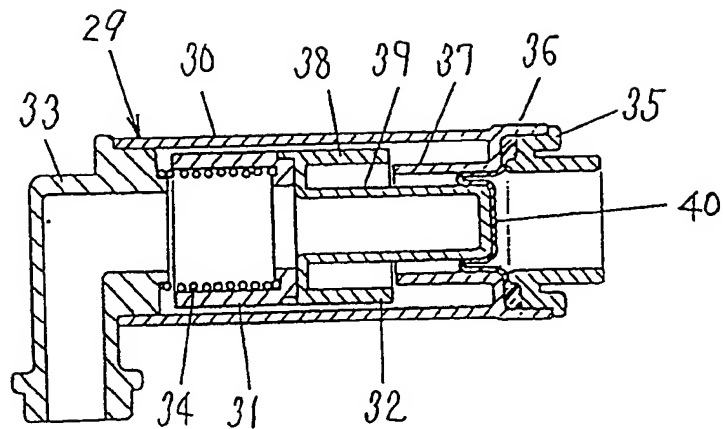


FIG. 6

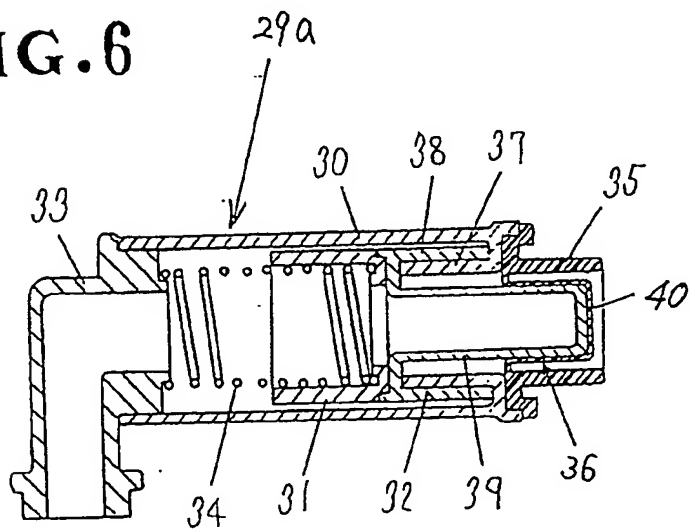


FIG. 7

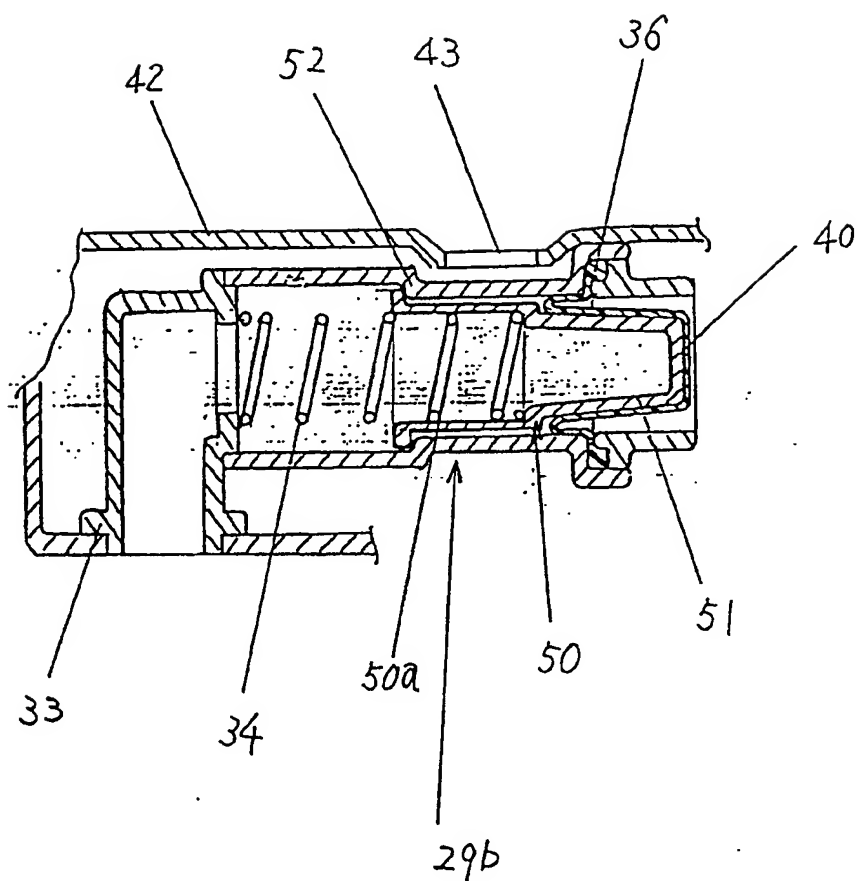
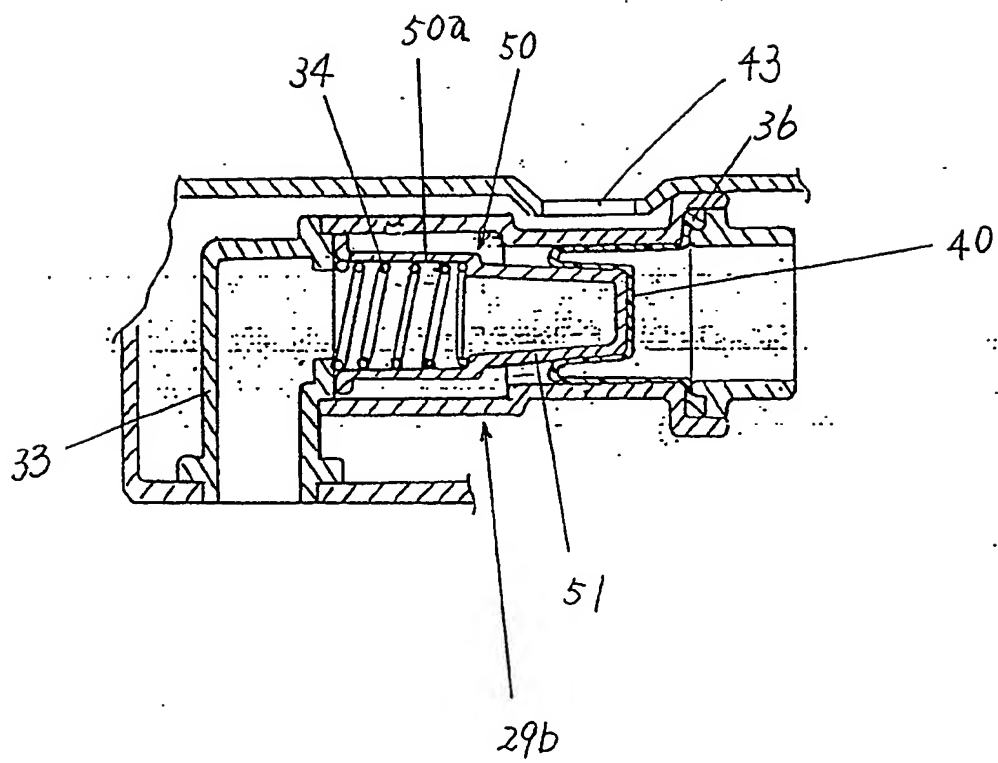


FIG. 8





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 12 2569

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
E	PATENT ABSTRACTS OF JAPAN vol. 14, no. 370 (C-747)(4313) 10 August 1990, & JP-A-2 134124 (SANYO ELECTRIC CO LTD) 23 May 1990, * the whole document *	1	A47L9/19
Y	US-A-3119369 (P.W. HARLAND & AL) * column 1, line 67 - column 2, line 71; figures 1-4 *	1, 4, 5, 7	
Y	FR-A-782776 (INVENTIA PATENT-VERWERTUNGS) * the whole document *	1, 4, 5, 7	
A	DE-A-2638672 (AB ELECTROLUX) * page 2, last paragraph - page 5, last paragraph; figure 1 *	1	
A	FR-A-2333480 (AB ELECTROLUX) * page 1, line 1 - page 3, line 17; figures *	1	
A	US-A-2283831 (C.H. TAYLOR) * column 2, line 41 - column 4, line 32; figures 3, 4 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	GB-A-2107605 (HOOVER PLC) * abstract; figure 2 *		A47L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20 FEBRUARY 1991	Examiner VANMOL M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			